The NIST Analyses: A Close Look at WTC 7

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Preface

The following comments and questions describe why I consider the Final Reports NCSTAR 1A, 1-9 and 1-9A to be incomplete, inconsistent and erroneous. Sincere thanks are due to Chris Sarns, Andrew Donlan, Gregg Roberts, David Chandler and Dwain Deets for their helpful comments. I hope many others will spend the time to evaluate the NCSTAR reports carefully, follow the references herein, and draw their own conclusion. Public disclosure of one's convictions is always a risk, but silent acceptance is not an option. Permission is granted to reprint or quote excerpts freely and solely without charge.

Introduction

Many architects, engineers and others have never seen the rapid descent of the 47-story World Trade Center Building Seven (WTC 7) into its footprint in less than seven seconds on the afternoon of September 11, 2001. This unprecedented event—the first steel-frame building in history to collapse suddenly and completely following an uncontrolled office fire—was captured on film from various angles. Engineers at the National Institute of Standards and Technology (NIST) performed extensive thermal and structural analyses of the building in an attempt to explain the complete collapse in terms of impact damage, fire damage, column buckling and progressive collapse. This extraordinary effort by NIST provides a close-up view inside WTC 7 during the final hours, minutes and seconds before its precipitous fall. But the discovery of extreme temperatures as well as residues of molten iron and highly reactive pyrotechnic material in the World Trade Center debris[1] [2] [3] invalidates the NIST conclusions, and

[1] Niels H. Harrit et al., "Active Thermitic Material Discovered in Dust from the 9/11 World Trade Center Catastrophe", The Open Chemical Physics Journal, 2009, Volume 2.

[2] Steven E. Jones et al., "Extremely High Temperatures during the World Trade Center Destruction", Journal of 9/11 Studies, Volume 19, January 2008.

[3] Jonathan Barnett et al., FEMA 403, <u>World Trade Center Building Performance Study: Data Collection, Preliminary Observations, and Recommendations</u>, May 2002, Appendix C, "Limited Metallurgical Examination".

further independent investigation is required.

The purpose of this article is to closely examine the contents of the final National Construction Safety Team Act Report (NCSTAR)[4] numbers 1A, 1-9 and 1-9A in an effort to understand the NIST hypotheses, methods of analysis and conclusions. Careful examination is necessary to verify how NIST has fulfilled its duty to the public as required by the National Construction Safety Team (NCST) Act of 2002.[5] One of the duties charged to NIST under this law is to establish the most likely technical cause of the building failure; NIST has succeeded in casting serious doubt on the credibility of its conclusions by focusing solely on the analytical aspects and by ignoring relevant physical and testimonial evidence. This article does not constitute proof that explosives were present in the building. Simply demonstrating that NIST has not fulfilled its mandatory duty to the public is sufficient grounds to call for a new investigation of the incident, and any meaningful investigation must account for all of the relevant evidence. More than a year has elapsed since the final reports were issued in November 2008, and the goal of this article is to establish agreement—supported by facts—that a new investigation is necessary to explain the complete destruction of WTC 7.

Anyone reading this article knows the events of 9/11 have changed our lives. The "global war on terror" was immediately declared, and wars in Afghanistan and Iraq were initiated. These wars continue—more than eight years later—with no clear goal and no end in sight. Many citizens worldwide consider the "Muslim hijacker" conspiracy theory promoted by media and government sources to be false, and there is still no hard evidence to confirm its veracity. Many citizens worldwide also know that an understanding of 9/11 is essential to achieving a peaceful resolution to current conflicts. This effort is dedicated to the thousands of innocent victims of 9/11 and their families including citizens of Iraq and Afghanistan, the first responders, survivors, witnesses, friends and colleagues who continue to search for honest answers to extremely difficult questions.

The NIST Hypothesis

The NIST authors have not proven their hypothesis regarding the fate of WTC 7. The summary report allegedly "describes how the fires that followed the impact of debris from the collapse of WTC 1 (the north tower) led to the collapse of WTC 7;"[6] the report actually describes the NIST hypothesis for a fire-induced collapse of WTC 7 based on complex computer simulations. The NIST conclusions are not based on physical evidence that can be

[4] All of the NCSTAR reports can be found at http://wtc.nist.gov.

[5] U.S. Congress, H.R. 4687, "National Construction Safety Team Act", 107th Congress, 2nd Session, January 2002.

[6] S. Shyam Sunder et al., NIST NCSTAR 1A, Final Report on the Collapse of World Trade Center Building 7, Washington: U.S. Government Printing Office, November 2008, p. xv.

tested and confirmed by others. NIST frequently uses the term "probable collapse sequence"[7] to describe their hypothesis, but their report never quantifies this probability. A preliminary study of WTC 7 published by the Federal Emergency Management Agency (FEMA)[8] concluded that the best hypothesis of a fire-induced collapse had only a low probability of occurrence, so the NIST conclusions still reflect a significant degree of uncertainty.

Various hypotheses were considered for the initiation of complete global collapse. The possibilities considered by NIST included (1) a fire-induced local failure leading to vertical and horizontal failure progression throughout the entire structural system, (2) a fire-induced failure from burning diesel fuel leading to complete global collapse, and (3) a blast-induced demolition scenario. According to NIST:

> The leading hypothesis for the failure sequence that characterized the initial local failure was based on fire-induced failure events in the tenant floors.[9]

A heat-induced column failure hypothesis was quickly ruled out after concluding the fires were not hot enough for the duration of time required to reduce the steel strength by 50 percent.

> Therefore, it would not have been possible for a building contents fire to have heated a massive, insulated column such as Column 79 to the point of failure.[10]

The NCST Act was signed into law in 2002, and it specifies NIST's responsibility to "establish the likely technical cause or causes of the building failure;" the focus of the WTC 7 investigation as defined by NIST is not the same as establishing the likely cause of collapse.

> The challenge was to determine if a fire-induced floor system failure could occur in WTC 7 under an ordinary building contents fire.[11]

In its brief dismissal of the controlled-demolition scenario, NIST argues that careful preparation of columns for demolition could not be accomplished without detection, and "Controlled demolition usually prepares most, if not all, interior columns in a building with explosive charges, not just one column."[12] While NCSTAR authors imply that demolition of multiple columns would be required and unlikely, the same authors conclude that the buckling failure of a single column was sufficient to trigger a complete progressive collapse of the entire building. If a single-column failure could bring the entire

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[7] NCSTAR 1A, p. xv.

[8] Ramon Gilsanz et al., FEMA 403, Ch. 5, "WTC 7", p. 5-31.

[9] Therese P. McAllister et al., NIST NCSTAR 1-9, Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7, Washington: U.S. Government Printing Office, November 2008, p. 323.

[10] NCSTAR 1-9, p. 330.

[11] NCSTAR 1-9, p. 331.

[12] NCSTAR 1-9, pp. 614-15.

building down, it does not matter how that column was removed. If a man-made collapse required extensive preparation to deliberately break every column on multiple floors, then a "natural" single-column failure could not possibly cause rapid, symmetrical, and complete global collapse—straight down in classic controlled-demolition style.

> Observations for WTC 7 do not match the typical sequence of events for a controlled demolition.
>
> This collapse sequence is inconsistent with a typical controlled demolition…[13]

There are thousands of alert and well-informed citizens worldwide, including scientists, demolition experts, architects and structural engineers, who disagree with the preceding statements. Furthermore, the collapse sequence referred to by NIST is the one taking place during their computer simulation—a sequence of events invisible to witnesses and, to a significant extent, under the control of NIST analysts. There is no need for further speculation; an independent investigation of the incident is required.

Only *fire-induced floor-system failure* was seriously considered by NIST as the cause of collapse initiation. Abundant and well-documented evidence suggesting the controlled demolition of WTC 7—including news videos, witnesses hearing explosions, foreknowledge of the collapse, first-responder reports of molten metal in the debris, extreme surface temperatures recorded by NASA thermal imaging for weeks following the collapse, and evidence of melted structural steel—was simply ignored.[14] It is difficult to imagine how anyone interested in establishing the likely technical cause of the building failure could ignore evidence of a "liquid eutectic mixture containing primarily iron, oxygen and sulfur formed during this hot corrosion attack on the steel."[15] This was obviously not caused by an ordinary fire consuming only building contents.

Building Code Issues

NIST discusses building code requirements in effect at the time of construction.[16] The minimum fire-rating requirement for WTC 7 was stated: "For a sprinklered building, a Type 1-C classification required a 2 h fire resistance rating on the columns and a 1.5 h fire resistance rating on the floors."[17] In the same paragraph NIST admits "In this report, Type 1-C classification was assumed, but the actual classification may have been type 1-B." The Type 1-B classification—more restrictive than Type 1-C—required a three-hour rating on the columns and a two-hour rating on the floors including girders, beams and the underside of metal deck. Drawings, specifications and spray-on fireproofing thickness measurements all indicated a Type

[13] NCSTAR 1-9, p. 615.

[14] See www.ae911truth.org for an excellent overview of the evidence.

[15] Barnett et al., FEMA 403, Appendix C, p. C-1.

[16] NCSTAR 1-9, p. 11.

[17] NCSTAR 1-9, p. 12.

1-B classification for WTC 7. NIST engineers, however, assumed a less fire-resistant construction classification when all documentation indicated otherwise.

NIST recommended several improvements to building codes including a list of characteristics for infrequent fires that should be considered in structural design.

> …historical data suggests that infrequent fires which should be considered in structural design involve: ordinary combustibles and combustible load levels, local fire origin on any given floor, no widespread use of accelerants, consecutive fire spread from combustible to combustible, fire-induced window breakage providing ventilation for continued fire spread and accelerated fire growth, concurrent fires on multiple floors, and active fire protection systems rendered ineffective. The fires in WTC 7 involved all of these.[18]

The statement that fires in WTC 7 included no widespread use of accelerants is unsubstantiated. Extensive documentation in the NCSTAR reports does not indicate that NIST ever tested debris samples for accelerants, incendiary or pyrotechnic compounds following the WTC 7 fires, and such an obvious omission casts serious doubt on their conclusions. In fact, as late as 2009, NIST defended its decision not to test any of the WTC debris for explosive residues claiming that "such testing would not necessarily have been conclusive."[19] Yet such testing might have *been* conclusive. While the National Fire Protection Association publication "NFPA 921: Guide for Fire and Explosion Investigations" counsels caution in interpreting the results of such testing, it does *not* state that such tests are not required if the results *might* be inconclusive. NIST thus chose to remain willfully ignorant as to the presence of detectable explosive residues. Its rationale seems flawed, if not disingenuous.

Current building codes require structural design for life safety and stability under normal use and some extreme loading conditions. NIST contends that "current model building codes do not require that buildings be designed to resist progressive collapse."[20] Progressive collapse is defined as "the spread of local damage from a single initiating event, from structural element to element, eventually resulting in the collapse of an entire structure or a disproportionately large part of it."[21] An extensive code change titled "Disproportionate Collapse" was proposed in response to NIST's recommendations, but it was not adopted

[18] NCSTAR 1A, p. 64.

[19] Catherine S. Fletcher, "Letter in response to request for corrections," Journal of 9/11 Studies, July 2009, http://journalof911studies.com/volume/2007/NISTresponseToRequestForCorrectionGourleyEtal2.pdf.

[20] NCSTAR 1A, p. 60.

[21] NIST, "Questions and Answers about the NIST WTC 7 Investigation (Updated 12/18/2008)," http://www.nist.gov/public_affairs/factsheet/wtc_qa_082108.html.

into the 2009 International Building Code (IBC). *Progressive collapse* has now become the cliché explanation for all three World Trade Center collapses, but this cannot account for the chemical composition of the debris.

Lateral Ejections from WTC 1

Thousands of people witnessed World Trade Center Tower 1 (WTC 1) collapse suddenly and completely in 10-15 seconds following impact and the subsequent fire. Ample visual evidence is available in the form of photographs and videos taken on 9/11/01, including numerous photographs of the WTC 1 destruction.[22] NIST reports:

> When WTC 1 collapsed at 10:28:22 a.m., most of the debris landed in an area not much larger than the original WTC 1 building footprint. However, some fragments were forcibly ejected and traveled distances up to hundreds of meters.[23]

The FEMA report clearly states: "The debris field extended as far as 400-500 feet [120-150 meters] from the tower base."[24] Figure 2-23 of the FEMA report shows an aerial photograph where a significant amount of debris—certainly more than a few fragments—from each tower landed up to a hundred meters away from the tower's base. The NIST discussion of damage caused to WTC 7 by flying debris from WTC 1 includes the following statements.

> …several substantial pieces of debris were expelled outward toward WTC 7 from the main cloud of the falling material.[25]

> …the exterior walls of the towers were constructed from preassembled steel panels consisting of three story columns joined by spandrels to form a 3.0 m wide x 11.0 m high (10 ft x 36 ft) wall section.[26]

> The appearance of the falling object in Figure 5-41 suggests that it was formed from at least one panel section.[27]

A kinematic analysis of this projectile was performed by physics instructor David S. Chandler.[28] His calculations reveal an initial horizontal velocity component of over 70 miles per hour (nearly 32 meters per second.) Other steel panels were thrown laterally from WTC 1 up to 500 feet (150 meters) to impact the World Financial Center across West Street. The NIST report does not explain the lateral force or energy source capable of hurling a perimeter column/spandrel unit weighing at least 6,000 pounds to impact WTC 7. NIST, therefore,

[22] NCSTAR 1-9, Ch. 5, Fig. 5-40—5-46, pp. 131-40.

[23] NCSTAR 1A, p. 16.

[24] Ronald Hamburger et al., FEMA 403, Ch.2, "WTC 1 and WTC 2", p. 2-27.

[25] NCSTAR 1-9, p. 130.

[26] NCSTAR 1-9, p. 133.

[27] NCSTAR 1-9, p. 133.

[28] David S. Chandler, "Another High Speed Ejection from WTC 1", See http://www.youtube.com/watch?v=djwBCEmHrSE.

has not established the likely cause of initial damage to WTC 7 on 9/11/01.

Eyewitness Observations

The NIST account of eyewitness observations contains several glaring contradictions. The following statements imply those remaining inside WTC 7 at 10:30 a.m. had no intention of leaving.

> By the time WTC 2 collapsed at 9:59 a.m., all the building occupants who intended to leave WTC 7 had done so.[29]
>
> NIST was unable to find any evidence that, by approximately 10:30 a.m., any of the original occupants who intended to leave WTC 7 had not already done so (Chapter 7).[30]

The preceding statements are false considering the following testimonial evidence.

> Investigation interviews indicated that this window was broken out by people who were trapped on this floor when WTC 1 collapsed (Chapter 6). Video clips in the database show one of these people inside an open window (8-42A) on the eastern edge of the north face.[31]
>
> As all of the emergency responder restructuring operations were underway, three people became temporarily trapped inside WTC 7. Two New York City employees had gone to the OEM Center on the 23rd floor and found no one there.[32]

Not everyone had evacuated WTC 7 by the time WTC 1 collapsed. WTC 7 interview numbers 2041604 and 1041704 from 2004 are cited regarding the two New York City employees. The WTC 7 interviews listed in the NIST report have not been released, but Dylan Avery's interview with Barry Jennings, who was trapped inside WTC 7 when both of the Twin Towers collapsed, is available.[33] His personal experience on 9/11 included explosions inside WTC 7 prior to the collapse of WTC 1. This indicates, again, that NIST has not established the likely cause of initial structural damage to WTC 7.

Impact Damage to WTC 7

The structural damage described by NIST is attributed to flying debris from WTC 1 which was located over 300 feet (90 meters) to the south of WTC 7. The location and extent of damage is especially significant because the horizontal progression of failures during the global collapse sequence reported in NCSTAR 1-9 and 1-9A depends on significant interior damage to the western core structure, even though NIST clearly

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29 NCSTAR 1A, p. 16.

30 NCSTAR 1-9, p. 297.

31 NCSTAR 1-9, p. 180.

32 NCSTAR 1-9, p. 298.

33 Dylan Avery, "Barry Jennings Uncut", See http://www.prisonplanet.com/barry-jennings-uncut.html.

states that significant damage to the core framing was unlikely. Figures 5-92 through 5-101[34] graphically show the extent of impact damage based on visual data. NIST concludes the following in the summary of debris damage to WTC 7:

> …it is likely that the structural damage (steel and floor slabs) did not penetrate beyond the perimeter of the building core.[35]
>
> …there was relatively little damage to the interior of WTC 7.[36]
>
> WTC 7 withstood debris impact damage that resulted in seven exterior columns being severed…[37]
>
> The structural damage to WTC 7 was primarily located at the southwest corner and adjacent areas of the west and south faces, on Floors 5 through 17. Severed columns were located between Floors 7 and 17 on the south face (six columns) and the west face (one column) near the southwest corner.[38]
>
> The core columns and girders were assumed to be structurally undamaged.[39]

[34] NCSTAR 1-9, pp. 183-87.

[35] NCSTAR 1A, p. 16.

[36] NCSTAR 1A, p. 16.

[37] NCSTAR 1A, p. 47.

[38] NCSTAR 1A, p. 50.

[39] NCSTAR 1-9, p. 182.

This summary of structural damage due to debris impact indicates no damage to floor framing in the western core. The following statement regarding the analysis of debris impact and collapse progression from east to west through the core structure demonstrates the contradiction between statements based on visual data and statements based on the analytical model.

> In the analysis with debris impact damage, the core framing damage on the west side resulted in a more rapid failure of the west interior columns in the last stages of the horizontal progression.[40]

NCSTAR 1-9 Section 12.4.2 is titled "Building Response to Debris-Impact Damage." This section, however, does not say how the debris-impact damage was estimated. A graphical summary of vertical displacements following application of the impact damage is shown, but there is no discussion of the extent of damaged framing and connections assumed in the analysis. Figure 12-42 shows a "Failure of cantilevered floor framing in debris impact zone, due to accumulated damage in connections."[41] This occurs primarily in line with columns 67-69 (incorrectly labeled 67-75). Figures 12-48, 12-49 and 12-52 through 12-55[42] also show internal floor failures at the western core around columns 67-69. Finally, Figure 12-57 shows a "Secondary

[40] NCSTAR 1A, p. 43.

[41] NCSTAR 1-9, p. 573.

[42] NCSTAR 1-9, pp. 578-83.

collapse in western core due to early debris damage."[43] The buckling failure of the "Group 7" columns 59, 62, 65 and 68 contradicts the impact damage estimates in NCSTAR 1-9 Chapter 5 as shown in figures 5-92 through 5-101. So what was the source of the western core framing damage that helped the core collapse? The following clue still does not explain this mystery.

> Damage to the western core developed early in the initialization process as a result of the WTC 1 debris impact damage.[44]

Figure 4-39[45] shows what appear to be floor beams that are severed at mid span, and these beams appear to be supported only by the girder along the southwestern core perimeter. These cantilever beams were noted to cause girder connection failures at column 69 leading to column buckling, but it is not likely that falling debris would sever steel beams as shown in NCSTAR 1-9A Figure 4-39. The questions remain: does the structural model input data correspond to damage estimates documented in NCSTAR 1-9 Chapter 5, and is the input data realistic?

Fires

NIST states "The fires in WTC 7 were ignited as a result of the impact of debris from the collapse of WTC 1,"[46] but this remains an assumption because there was never a basic fire investigation to determine the exact source or nature of the fires. There were fires reported in WTC 7 after the debris cloud cleared,[47] but these accounts do not pinpoint the initial source of fire. NIST admits that the source of the fire is unknown.

> The specific ignition processes are not known, e.g., whether from flaming brands, electrical shorts, etc.[48]

What other possibilities are included in the "etcetera" category? Was arson a possibility? How about evidence of incendiary or pyrotechnic materials found in the debris? Why has NIST neglected to investigate these possibilities? It is apparent that this type of criminal investigation was declared "beyond the scope" of the WTC 7 study, but even NIST cannot determine the most likely cause of building failure without a complete accounting of the facts.

NIST describes the fire simulations performed using their Fire Dynamics Simulator (FDS). The purpose of the fire dynamics simulation is to model the growth, spread and temperature distribution of the fire. The Overview[49] provides no real evidence—photographic, eyewitness or

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[43] NCSTAR 1-9, p. 584.

[44] Robert MacNeill et al., NIST NCSTAR 1-9A, Global Structural Analysis of the Response of World Trade Center Building 7 to Fires and Debris Impact Damage, Washington: U.S. Government Printing Office, November 2008, p. 83.

[45] NCSTAR 1-9A, p. 94.

[46] NCSTAR 1A, p. xxxvi.

[47] NCSTAR 1-9, p. 301.

[48] NCSTAR 1-9, p. 47.

[49] NCSTAR 1-9, p. 361.

otherwise—leading to a conclusion that the collapse of WTC 1 started the fires on floors seven through nine and 11 through 13. Calculations performed for WTC 7 were similar to those performed for the Twin Towers, but NIST admits "the details of these fires are not as precise as for the fires in the towers."[50] The uncertainty of the calculations based on little visual or other evidence is implied.

> …the ignition and early course of the fires were unknown because they were presumed to have occurred in the damaged and heavily smoke-shrouded southern portion of the building.[51]

Regarding the spread of fire on the 12th floor, NIST says "The floor plan suggests that fire may have spread onto the east face from the south by moving along a corridor."[52] Corridors in office buildings have practically no combustible materials, so this assumption may be inconsistent with the calculations. Additional photographs and statements magnify the uncertainty in the NIST prediction of fire dynamics. For example the northeast corner of WTC 7 was photographed with the camera facing south at around 4:00 p.m. on 9/11/01. In NIST's words "…there is no indication of fires burning on the east side of the 12th floor at this time."[53] The north face at floors 10 through 14 was also photographed at around 4:38 p.m. In NIST's words "All of the visible windows on the 12th and 13th floors are open in Figure 5-149. There is no indication of fire at these locations on either floor."[54] Indeed, all the windows appear dark. NIST also states "Closer inspection of Figure 5-142 reveals what appears to be a relatively light plume of white smoke rising from near the top of the louvers that spanned the 5th and 6th floors on the east face."[55] According to NIST, however, "The floors below Floor 7…did not heat significantly due to the absence of fire activity."[56] So what was the source of the white smoke from below floor seven?

Gas temperatures predicted by the FDS were applied to the 16-story ANSYS structural model and the 47-story LS-DYNA model via the Fire Structure Interface (FSI). Case A temperatures were obtained directly from the fire-dynamics calculations, Case B temperatures were increased 10 percent above Case A, and Case C temperatures were decreased 10 percent below Case A.

> Given the limited visual evidence, the Investigation Team estimated, using engineering judgment that a 10 percent change was within the range of uncertainty in the extent and intensity of the fires.[57]

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[50] NCSTAR 1-9, p. 362.

[51] NCSTAR 1-9, p. 377.

[52] NCSTAR 1-9, p. 200.

[53] NCSTAR 1-9, Fig. 5-141, p. 227.

[54] NCSTAR 1-9, p. 235.

[55] NCSTAR 1-9, p. 228.

[56] NCSTAR 1-9, p. 394.

[57] NCSTAR 1-9, p. 4.

> A 10 percent increase or decrease in gas temperatures resulted in a roughly 30 percent increase or decrease in the heat flux to structural members.[58]

Engineering judgment is a useful tool, and this enables us to assume Case C temperatures are equally likely as Case A or Case B temperatures. Also by engineering judgment, a 30 percent increase or decrease in heat transfer to structural members is a reasonable approximation based on the probabilistic nature of the NIST analyses. All three cases should have an equal statistical probability considering the fact that Case B and Case C were derived by engineering judgment as a reasonable representation of reality.

The 16-story ANSYS model was subjected to the Case A temperatures, as well as 10 percent higher Case B temperatures and 10 percent lower Case C temperatures. All three cases resulted in similar structural damage to the ANSYS model except the failure time required, as expected, was shorter for the higher Case B temperatures than the failure time required for the lower Case C temperatures. At this point NIST declared:

> …only the fire-induced damage produced by Case B temperatures was carried forward as the initial condition for the LS-DYNA analysis (Chapter 12), since the damage occurred in the least computational time (about 6 months).[59]

> The ANSYS results [Case B at four-hour duration] were input to the LS-DYNA analysis when it appeared that an initial failure event might be imminent.[60]

The first statement above implies the reason for choosing Case B temperatures (and discarding cooler Cases A and C) was for computational efficiency, but the latter statement suggests that an initial failure event may not have occurred in the LS-DYNA model without a boost from the fire-induced damage data from the ANSYS analysis. The fire-induced damage estimated from Case B temperatures at four-hour duration were enough to cause an unstable structural model, but the fire-induced damage estimated from Case B temperatures at 3.5 hours was not enough to cause global instability of the LS-DYNA model.[61] It is likely that cooler Case A or C temperatures at four-hour duration would not have led to the prediction of global instability.

> The simulations of the Floor 12 fires (and thus the derivative Floor 11 and 13 fires) may have overestimated the duration of the fires and the fraction of the burning near the north face windows, relative to the fraction of

[58] NCSTAR 1-9, p. 391.

[59] NCSTAR 1-9, p. 6.

[60] NCSTAR 1A, p. 36.

[61] NCSTAR 1-9A, p. xlvi.

> burning in the interior of the tenant space.[62]

The LS-DYNA analysis using fire-induced damage estimates resulting from Case B temperatures at 3.5-hour duration did not lead to a prediction of global collapse.[63] An overestimate of fire duration of ½ hour (about 12 percent) led to a conclusion supporting global collapse as opposed to a conclusion not supporting global collapse. Also, an overestimate of the fraction burning near the windows must have also led to an overestimate of temperatures due to increased oxygen available near the windows.

> The floors below Floor 7, Floor 10, and the floors above Floor 14 did not heat significantly due to the absence of fire activity. The exterior columns and core columns also did not heat significantly on the fire floors.[64]

> The connection, beam, and girder failures in the floor systems, and the resulting structural responses, occurred primarily at temperatures below approximately 400° C (750° F), well below the temperatures at which structural steel loses significant strength and stiffness.[65]

None of the column elements in the entire ANSYS model were heated enough to lose any significant strength or stiffness.

Nevertheless, NIST claims "The fires thermally weakened Floors 8 to 14."[66] The question remains: Did NIST simply "turn up the heat" on the FDS, ANSYS and LS-DYNA analyses to create the global instability necessary to demonstrate a correlation with events observed on 9/11?

Structural Modeling

NIST created numerous finite-element models for the thermal and structural analyses of WTC 7. These models simulated structural components such as core columns and beam-column connections, subsystems such as partial and full tenant floors, and the global structure. The two global models included (1) the lower 16-story ANSYS model and (2) the 47-story LS-DYNA model. NIST was obviously concerned about obtaining reasonable results under extreme computational demands, and NIST analysts made many simplifying assumptions.

> Modifications were made to reduce the model size and complexity and enhance computational performance without adversely affecting the accuracy of the results.[67]

NCSTAR 1-9 Section 8.8 describes the finite-element analysis of a partial single-floor framing system bounded by interior column 79 and exterior columns 44, 42 and 38. This is the area blamed for the collapse initiation; this is the subsystem model that predicted failure of shear-studs and girder

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[62] NCSTAR 1A, p. 52.

[63] NCSTAR 1A, p. 42.

[64] NCSTAR 1-9, p. 394.

[65] NCSTAR 1A, p. 53.

[66] NCSTAR 1A, p. 54.

[67] NCSTAR 1-9, p. 5.

connections, beam buckling and excessive lateral displacement of a girder at column 79—all triggering collapse initiation. The purpose of this subsystem analysis was to demonstrate "possible failure mechanisms that were used to develop the leading collapse hypothesis further."[68] Girder and beam temperatures were assumed to be 500 degrees and 600 degrees Centigrade respectively, and the slab was assumed to remain unheated.[69]

> No thermal expansion or material degradation was considered for the slab, as the slab was not heated in this analysis.[70]

Why not? The concrete floor slab could not possibly remain unheated in an atmosphere where steel beams supporting the slab were heated to 600 degrees. The beams were coated with thermal insulation, so the air temperature would have been even hotter than 600 degrees.

> The boundary conditions and temperatures were selected to create maximum shear forces on the stud connectors and beam and girder connections.[71]

Obviously the NIST partial-floor model did not allow the slab to expand thermally with the steel beams, and neglecting thermal expansion of the slab has the effect of imposing additional relative displacement on the shear studs connecting the concrete to the steel. This subsystem analysis formed the basis for special connection elements used in the global analyses as described in the following passages.

> The failure modes in this model [the partial floor] were incorporated into the 16 story ANSYS and 47 story LS-DYNA analyses.[72]

> These results helped to guide the development of special connection elements…that captured the salient features and failure modes of the various types of connections used in the floor system of WTC 7.[73]

NIST states that "even though steel and concrete have similar coefficients of thermal expansion, differential thermal expansion occurred between the steel floor beams and concrete slab when the composite floor was subjected to fire."[74] This relative displacement occurred in the ANSYS model, and no physical testing was done to verify its magnitude in the steel-and-concrete structure. Obviously NIST took steps to maximize the destructive effects of any relative displacement due to thermal movement.

NCSTAR 1-9 Chapter 11 discusses structural analysis of the initial failure event based on the 16-story ANSYS model. Although this model was capable of

[68] NCSTAR 1-9, p. 353.

[69] NCSTAR 1-9, p. 349.

[70] NCSTAR 1-9, p. 352.

[71] NCSTAR 1-9, p. 349.

[72] NCSTAR 1-9, p. 353.

[73] NCSTAR 1-9, p. 359.

[74] NCSTAR 1-9, p. 490.

including thermal conductivity, NIST does not mention this important material property.

> The [ANSYS] model accounted for nonlinear geometric effects, temperature dependent behavior of members and connections (including thermal expansion and stiffness and strength degradation), the sequential failure of structural framing and connections under fire conditions, and removal of failed elements (with user intervention).[75]

Heat transfer within structural elements and between structural elements was considerable in the steel framing, and it dissipated heat energy from the hottest parts of the steel. Did the analysts consider heat transfer, or was this property simply ignored to enhance computational performance?

ANSYS results were input to the LS-DYNA model.

> The purpose of the ANSYS model was to simulate the accumulation of local damages and failures up to the initiation of overall global collapse due to fire.[76]

> The fire-induced damage from the ANSYS model were [sic] input into the LS-DYNA model as initial conditions.[77]

> …it was not necessary to input more than one solution to the global analysis of the collapse. The fire-induced damage produced by Case B temperatures at 4.0 h was carried forward as the initial condition for the LS-DYNA analysis.[78]

> Column splices were also not modeled for interior columns, as the purpose of the ANSYS model was to accumulate local failures up to the point of buckling in a column. When column buckling appeared to be imminent, the analyses were continued in the LS-DYNA 47 story model.[79]

The preceding statements imply that the 47-story LS-DYNA model was initially damaged due to preexisting fire effects, and NIST controlled the initial conditions by using the 16-story ANSYS model to predict an initial failure state for the 47-story model. The LS-DYNA model was loaded with gravity dead loads plus 25 percent of the original design live loads in addition to the high-temperature thermal loading Case B. The initial damage state for the LS-DYNA model included debris impact damage from WTC 1 plus the accumulated fire-induced damage predicted by the ANSYS analysis. Was the LS-DYNA model capable of predicting the initial failure resulting from the Case B temperature distribution without preexisting damage imposed?

NIST enlisted Applied Research Associates (ARA) to provide analytical assistance with the 47-story model of WTC 7. The

[75] NCSTAR 1-9, p. 457.

[76] NCSTAR 1-9, p. 484.

[77] NCSTAR 1-9, p. 457.

[78] NCSTAR 1-9, p. 535.

[79] NCSTAR 1-9, p. 476.

following statements in the agreement between NIST and ARA[80] demonstrate the nature of the collaboration as it relates to the WTC 7 analyses.

> ARA will conduct analyses, in collaboration with NIST, to determine the location and cause of the initiating event...
>
> NIST will conduct all fire analysis of the building and analysis of the structural response to fires in-house and supply ARA initiating event data based on the in-house analyses.
>
> The detailed floor analyses will determine likely modes of failure for Floors 8 to 46 due to failure of one or more supporting columns…
>
> Final analyses will support the determination of the location and cause of the initiating event, by incorporating data from NIST for simulating the initiating event, as well as the location and cause of subsequent failures that led to global collapse.

NIST supplied the initiating event data even though the contract states that ARA would perform analyses to determine the location and cause of collapse initiation. ARA only looked at failure modes of floors eight through 46 even though previous engineering studies by FEMA engineers stated clearly that "the most likely [structural failure] event would have been the collapse of Truss 1 and/or Truss 2 located in the east end of the 5th and 6th floors."[81] According to the contractual language ARA did not look for possible failure modes on floors one through seven, and the analysis documented by ARA was *required* to support the initiating-event hypothesis as determined by NIST.

The Introduction to NCSTAR 1-9A clearly states the purpose of the LS-DYNA analysis.

> The purpose of this work was to analyze the global response of WTC 7 to an initial failure event due to fire and to analyze the resulting component and subsystem failures to determine the events that led to the global collapse.[82]

The initial failure event was predetermined by NIST. ARA was not responsible for analysis of the structural response to the fires and varying temperature distribution from the start, although LS-DYNA is capable of analyzing thermal softening and thermal expansion of structural materials. NCSTAR 1-9A also states the LS-DYNA model of WTC 7 "was focused on capturing the entire collapse initiation and collapse propagation process of the building…"[83] This is clearly false; the LS-DYNA model of WTC 7 was initialized with data representing fire-induced damage that NIST

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[80] NIST, "WTC 7 Structural Analysis and Collapse Hypotheses", See http://wtc.nist.gov/solicitations/wtc_awardQ0186.htm .

[81] Gilsanz et al., FEMA 403, Ch. 5, p. 5-28.

[82] NCSTAR 1-9A, p. 1.

[83] NCSTAR 1-9A, p. 1.

estimated had occurred leading to collapse initiation.

A two-floor subassembly model was constructed by ARA to "assess the model behavior for failure events during the model development and to assess the global model performance…"[84] Two temperature profiles were considered during the two-floor model analyses. These are described as Case A and Case B *at five hours*[85], but NCSTAR 1A and NCSTAR 1-9 discuss only temperature profiles with 3.5-hour and four-hour duration. The final reports are inconsistent with respect to this important detail.

ARA analyzed their two-floor model with several specific load cases in conjunction with the Case A and Case B temperatures at *five-hour duration*. Load Case 1 had no imposed (preexisting) connection or support failures.[86] The Case A temperature distribution did not lead to instability of the floor structure. The Case B temperature distribution predicted a partial collapse of the framing, but this did not occur at the east end of the building as predicted by the ANSYS analysis. Only Load Cases 2 and 3 exhibited a partial collapse at the east end of WTC 7, and these load cases imposed *preexisting* failures of connections at columns 79 and 81. Not one of the three load cases predicted a collapse of floor framing at the northeast corner as predicted by the ANSYS model—the event described by NIST as causing collapse initiation.

ARA also constructed a 14-story model that was used to evaluate the structural response to debris impact damage.[87] The subassembly model was determined to be stable following impact damage. The 14-story model was also used to evaluate the response to removal of column 79 support. The abrupt removal of support resulted in a vertical progression of collapse of all 14 floors at the northeast corner—no surprise. Also no surprise is the fact that it did not lead to a horizontal progression of failures resulting in complete collapse of the 14-story model. Unfortunately ARA did not include results or discussion of their 14-story model subjected to Case A and Case B temperature distributions *without any imposed damage to framing and connections* as they did with their two-story model. It would be helpful to know if the 14-story LS-DYNA model experienced similar results as the two-story model, or if fire-induced failures were predicted similar to the 16-story ANSYS model. Why was this important comparison and verification omitted from the report?

The 47-story LS-DYNA model is impressive with nearly 3,600,000 node points, over 3,000,000 shell elements, over 33,000 nonlinear spring elements, over 3,000 beam elements and nearly 2,500 solid elements.[88] The global model included gravity effects from 25 percent of the design

[84] NCSTAR 1-9A, p. 64.

[85] NCSTAR 1-9A, p. 65.

[86] NCSTAR 1-9A, p. 70.

[87] NCSTAR 1-9A, p. 73.

[88] NCSTAR 1-9A, p. xxxvi.

live load. This is reasonable for office areas with a design live load of 50 pounds per square foot (psf), but it may overestimate gravity effects in areas such as corridors, lobbies and other public areas that were evacuated on 9/11/01 and had no furniture, files or other miscellaneous weight to account for. Original design loads for WTC 7 are listed in Figure 11-17;[89] floors one through six and 21 through 23 were designed for live loads exceeding 50 psf. Floors supporting switchgear and mechanical equipment, such as floors five and six, are frequently designed for live loads of 100 psf or greater. But the lobbies, conference center, meeting spaces, and cafeteria located on floors one through four had practically zero live load on the afternoon of 9/11/01. Floors 21 through 23 were offices and also were evacuated.

The loads applied to the LS-DYNA global model included gravity, debris impact damage, Case B temperatures (applied smoothly in two seconds), and fire-induced damage from the ANSYS analysis.[90]

> In the model, the debris damage was instantaneously applied to approximate the actual dynamic event.[91]
>
> The final step in the initialization process was to apply fire-induced damage from the 16 story ANSYS analysis.[92]
>
> …the fire-induced damage obtained from the 16-story ANSYS analysis, including damage to floor beams, girders, and connections, was applied instantaneously.[93]
>
> Any imposed structural damage was applied instantaneously immediately following temperature initialization.[94]

The elevated temperatures and fire-induced damage to structural elements occurred over a period of several hours, and sudden removal of damaged structural elements does not account for a gradual redistribution of static loads. Thermal conductivity and heat flux affect the temperature distribution as a function of time. What effect does the rate of application of heat and fire-induced damage have on the global analysis? This is one more question the report does not address.

Damage to framing and connections was taking place in the LS-DYNA analysis prior to the application of the ANSYS estimated damage.

> During the temperature application cycle in the LS-DYNA analysis, combined thermal expansion and thermally degraded material properties resulted in beam and girder connection damage

[89] NCSTAR 1-9, p. 485.

[90] NCSTAR 1-9, p. 563.

[91] NCSTAR 1-9A, p. 83.

[92] NCSTAR 1-9A, p. 118.

[93] NCSTAR 1-9A, p. 51.

[94] NCSTAR 1-9A, p. 65.

> throughout the heated floor structures. The connection damage and buckled beam data transferred from the 16 story ANSYS analysis were then applied.[95]

If the application of elevated temperatures were sufficient to cause framing and connection damage throughout the floor structures, and the LS-DYNA analysis considered thermal expansion and thermally-degraded material properties, then why was it necessary to impose additional fire-induced damage determined by the NIST ANSYS analysis?

Models of framing connections used in the LS-DYNA analysis were compared to the ANSYS connection models.

> A comparison was performed between the LS-DYNA and ANSYS FHK [fin, header, and knife] shear connection models. The comparison showed good agreement for selected connections, which increased confidence in both of the separately developed modeling approaches.[96]

What is considered "good agreement", and what about connections other than the "selected connections"? NIST does not show any documentation of this comparison. NCSTAR 1-9A Figure E-2 shows the elements of a seated connection model.[97] This connection model appears to have the necessary components for prediction of connection performance and any failure due to thermal stresses. So why does the LS-DYNA global analysis depend on the 16-story ANSYS analysis performed by NIST to predict the fire-induced damage to framing members and connections? NIST attempts to explain this procedure.

> The ANSYS analysis estimated the damage that occurred as the fires grew and spread on Floors 7, 8, and 9 and Floors 11, 12, and 13. The LS-DYNA analysis, by comparison, considered only a temperature profile at the time when thermally-induced damage was transferred from the ANSYS analysis.[98]

This does not explain why the LS-DYNA analysis was not started cold and allowed to develop the thermally-induced damage from data provided by the NIST fire simulation. Not only does the LS-DYNA temperature profile go from zero to nearly 500 degrees Centigrade in two seconds, but the thermal damage estimated by NIST occurred gradually over several hours, and it was applied to the structural model instantaneously. This is not credible for a structural model used to predict the response and interaction of structural materials with time and temperature-dependent properties.

NIST compared visual observation times and analytical prediction times of various events leading up to and including the global collapse. The first entry in Table 3-1 of NCSTAR 1A indicates an observation time of minus six seconds for the cascading floor

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[95] NCSTAR 1-9A, p. 79.

[96] NCSTAR 1-9, p. 555.

[97] NCSTAR 1-9A, p. xxxvii.

[98] NCSTAR 1-9A, p. xxxix.

failures that preceded the buckling failure of column 79. This "event" was not observed by NIST or anyone else, so the table is erroneous to imply that it was observed before column buckling or the start of global collapse. The buckling of columns 79 through 81 and the horizontal progression of core column buckling were also not observed events as clearly shown in the table.

A significant discrepancy is obvious in the last two observations listed in Table 4-2 of NCSTAR 1-9A. These include the vertical motions of the roof-mounted screen wall (between the east and west penthouses) and the west penthouse. Visual observations clearly show the screen wall falling prior to the west penthouse. The global LS-DYNA model (including debris impact damage) indicates the west penthouse falling out of sequence prior to the screen wall, and NIST falsely claims "the simulation closely matched the observed behavior."[99] This is related to the column failures in the western core that occurred out of sequence in the global model. How do ARA and NIST explain this discrepancy?

Figures 4-13 and 4-14 of NCSTAR 1-9A illustrate the 47-story model during collapse progression. These figures are viewed from the northeast rather than the northwest as labeled, and they indicate significant distortion in the upper stories that were not apparent in any of the photographs or videos taken during the event on 9/11.

> This behavior created numerical difficulties in the analysis, which were not likely to occur in the structure.[100]

The "behavior" referred to above is the torque applied to spandrel beams from "softened" slab elements that carried floor live loads but had reduced stiffness. In some cases the supporting beam elements had failed and had been removed from the analysis. How many other numerical difficulties were encountered in the complex finite-element models that were not likely to occur in the steel and concrete structure?

> Computer simulations…can be used to predict a complex degradation and collapse of a building.[101]

This may be true, but computer simulations—regardless of their complexity—cannot replace an honest and complete forensic investigation of the collapse site and debris. As Professor E.L. Wilson points out with regard to computer simulations: "Remember the result obtained from a computer model is an estimation of the behavior of the real structure. The behavior of the structure is dictated by the fundamental laws of physics and is not required to satisfy the building code or the computer program's user manual."[102]

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[99] NCSTAR 1-9A, p. 120.

[100] NCSTAR 1-9, p. 489.

[101] NCSTAR 1-9, p. 625.

[102] Edward L. Wilson, Three Dimensional Static and Dynamic Analysis of Structures, Berkeley: Computers and Structures, Inc., 3rd Ed., April, 2000, p. 1-14.

Structural Details

Most engineers involved with building design and construction know that structural details are critical to the success of a project. It was common practice on the east coast when WTC 7 was built for the steel fabricator's detailer to design the framing connections using the Manual of Steel Construction, Eighth Edition, 1980 by the American Institute of Steel Construction (AISC). It was then the engineer's responsibility to review the detailer's shop drawings, including connection details, for conformance with the structural design.

NCSTAR 1-9 Figures 12-13 and 12-14 show schematic details of composite-floor construction at interior beams and girders. NIST concluded that the W33x130 girder spanning between exterior column 44 and interior column 79 had no shear studs to provide composite action with the concrete floor slab.[103] Although composite action was not required for the girder to carry its vertical floor load, good detailing practice would include shear studs if they were used elsewhere on the floor. Figure 12-14 shows a double row of studs on the interior girder, but refers to the framing plan for more information.[104] No shear studs were indicated for the girder on a partial framing plan,[105] and this was interpreted by NIST to mean no shear studs were provided. But simply omitting the number of studs from the structural framing plan does not prove that shear studs were not present on the interior girders. They could have been specified in written notes or specifications located elsewhere. Structural plans, and even fabrication drawings, do not always accurately reflect the existing construction; an examination of the steel debris before it was removed and destroyed would have answered this question.

Figure 8-21 of NCSTAR 1-9 shows the connection at column 79 supporting the W33x130 girder that spanned between columns 44 and 79. This column had three girders framing into it, but NIST says:

> The details of the connections of the other two girders are not shown.[106]

Why not? The other two girders also provided lateral bracing for column 79, and the connection details are important.

Damage to framing connections from the ANSYS analysis was applied to the LS-DYNA model as shown in NCSTAR 1-9 Figure 12-36 (and in NCSTAR 1-9A Figure 3-58.) A 100 percent failure state was assumed to occur for any calculated damage over 75 percent. The report says this assumption was made due to "the coarseness of the shell element modeling of the fin, knife, and header connections in the LS-DYNA model…"[107] Residual connection strength of 25 percent of the original strength, however, is substantial considering

[103] NCSTAR 1-9, p. 342.

[104] NCSTAR 1-9, p. 543.

[105] NCSTAR 1-9, p. 343.

[106] NCSTAR 1-9, p. 348.

[107] NCSTAR 1-9, p. 566.

the safety factor used to ensure adequate design. This illustrates another simplification assumed by NIST in favor of a progressive collapse.

> W14x730 refers to wide flange section that is nominally 14 in. deep end [sic] weighs 730 lb/ft.[108]

Actually a W14x730 wide-flange column is over 22 inches in depth with a three-inch thick web and five-inch thick flanges nearly 18 inches wide. This is the heaviest rolled steel section listed in the AISC Manual of Steel Construction, Eighth Edition. NIST grossly understates the size of these massive columns by implying a 14-inch depth.

<u>The Initiation Event</u>

Failure of the floor framing at the east end of floor 13 was blamed for initiating the series of events that led to complete collapse. A discussion of existing floor plans and combustibles includes the following statement:

> …there was some uncertainty regarding the nature of some spaces. Notably, the U.S. Securities and Exchange Commission (SEC) and American Express occupied all but the east side of the 13th floor, and NIST was unable to find people who recalled the nature of the unoccupied space.[109]

It is unlikely that those who managed the tenant spaces of this 47-story office building could not recall, or could not find out, who or what occupied the specific location where the collapse initiation was said to occur. Apparently NIST did not use their subpoena power to obtain this information from the building owner.

According to NIST the floor framing failed as a result of several factors including failure of shear studs, buckling of beams, and "walk off" of girders due to unrestrained thermal expansion of perpendicular beams.

> At this temperature [greater than 300 ºC.] in the shear studs, differential thermal expansion of the floor beams and floor slab resulted in significant shear force in the shear studs and caused them to fail.[110]
>
> Primarily for the east tenant floor, when a floor beam thermally expanded, the beam displaced the girder at the interior end of the floor beam but did not displace the exterior frame at the other end of the floor beam.[111]
>
> Many of the east floor beams on Floors 12, 13, and 14 failed by buckling, as shown in Figure 11-27 and Figure 11-35.[112]

NIST implies a restrained (pinned) support condition at the exterior frame and an unrestrained (roller) support condition at the interior girder. If the beams are unrestrained at one end, how can they develop the

[108] NCSTAR 1-9, p. 29, footnote 2

[109] NCSTAR 1-9, p. 48.

[110] NCSTAR 1-9, p. 473.

[111] NCSTAR 1-9, p. 526.

[112] NCSTAR 1-9, pp. 526-27.

compressive force necessary for buckling to occur? Alternatively, how can the beams push the girder laterally if they have buckled in compression?

Reasons listed for the loss of lateral support to columns 79 through 81 include the following.

> The buckling failure of the east floor beams and exterior columns was caused by restrained thermal expansion and failure of the shear studs along the beam length.[113]

It is not clear what buckling failure of exterior columns is referred to in the preceding statement, and NIST previously stated …the beam displaced the girder at the interior end of the floor beam but did not displace the exterior frame at the other end of the floor beam."[114] If thermal expansion of the floor beams did not displace the exterior frame, then buckling of exterior columns would not occur.

> The connection, beam, and girder failures in the floor systems, and the resulting structural responses, occurred primarily at temperatures below approximately 400° C (750° F), well below the temperatures at which structural steel loses significant strength and stiffness.[115]

> The thermal expansion of the WTC 7 floor beams that initiated the probable collapse sequence occurred primarily at temperatures below approximately 400° C (750° F).[116]

Unrestrained thermal expansion of 52 foot long beams was blamed for pushing a girder off its bearing seat at column 79. This linear expansion is about 3.5 inches at 400° C, but this is a full two inches short of the 5.5-inch lateral displacement required for loss of vertical support. "Walk off" is the term NIST used to describe the failure mode where a beam or girder moved axially or laterally off its bearing seat losing all vertical support. The walk-off failure was assumed to be complete when lateral displacement of the beam or girder end moved past the point at which the beam web was aligned vertically with the edge of the bearing seat.[117] One of the least "state-of-the-art" features of the complex analysis performed by NIST is the means by which they accounted for the lateral walk-off failure of the girder at column 79, and convincing documentation of this triggering failure mode is non-existent.

> A control element (COMBIN37), a unidirectional linear spring element with the capability of turning on and off during an analysis, was used to model walk-off.[118]

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[113] NCSTAR 1-9, p. 537.

[114] NCSTAR 1-9, p. 526.

[115] NCSTAR 1A, p. 53.

[116] NCSTAR 1A, p. 59.

[117] NCSTAR 1-9, p. 488.

[118] NCSTAR 1-9, p. 480.

> The travel distance for walk off was 6.25 in. along the axis of the beam and 5.5 in. lateral to the beam.[119]

Since the COMBIN37 element could only account for displacement in one direction (axially), what accounted for displacement in the lateral direction?

> A control element was used to model beam walk-off in the axial direction. Beam walk off in the lateral direction was monitored during the analysis.[120]

Monitored by what? NIST summarized the floor framing failures that led to collapse initiation, and *lateral* girder walk off at columns 79 and 81 was the failure mode allegedly responsible for the start of collapse.[121] Where are the analytical results that substantiate walk-off failures at columns 79 and 81? Where is the output data from the ANSYS analysis that confirms the lateral walk-off failures? A recent Freedom of Information Act (FOIA) request to NIST for analysis results that substantiate the walk-off failures was denied with the statement that "The NIST Director determined that the release of these data might jeopardize public safety."[122]

Collapse Progression

The exterior steel moment-resisting frame encompassed WTC 7 with 58 perimeter columns. Apparently all of these columns had to buckle within two seconds for the building to drop unimpeded straight down as seen in the video documentation.

> Exterior column buckling began at Column 14, adjacent to the debris impact zone near the southwest corner, between Floors 10 and 12.[123]

> Exterior column buckling spread from column to column, as loads were redistributed, until all the exterior columns had buckled between Floors 7 and 14 within approximately 2 s.[124]

Are the preceding statements describing the actual event on 9/11, and are they confirmed by witnesses, or are they simply statements describing the NIST computer simulations?

> In the analysis with debris impact damage, the core framing damage on the west side resulted in a more rapid failure of the west interior columns in the last stages of the horizontal progression.[125]

There was no core framing damage on the west side according to NCSTAR 1-9, page 182.

NCSTAR 1-9 Section 12.5.2 is titled "Aspects Following the Collapse Initiation." The NIST authors' style is exemplified in the first paragraph of this section with the following illumination.

[119] NCSTAR 1-9, p. 482.

[120] NCSTAR 1-9, p. 482.

[121] NCSTAR 1-9, p. 536.

[122] See http://cryptome.org/wtc-nist-wtc7-no.pdf.

[123] NCSTAR 1-9, p. 586.

[124] NCSTAR 1-9, p. 588.

[125] NCSTAR 1-9, p. 599.

> Once simulation of the global collapse of WTC 7 was underway, there was a great increase in the uncertainty in the progression of the collapse sequence, due to the random nature of the interaction, break up, disintegration, and falling of the debris. The uncertainties deriving from these random processes increasingly influenced the deterministic physics-based collapse process, and the details of the progression of the horizontal failure and final global collapse were increasingly less precise.[126]

The preceding statement by NIST implies that complete and rapid internal and external collapse was inevitable based on a computer simulation without any physical testing. Details of the actual collapse initiation, vertical progression and horizontal progression were not visible and have not been established by NIST based on any physical evidence, so "increasingly less precise" can only mean *unknown*.

NIST's summary of findings states:

> The horizontal progression of failure was sensitive to the extent of the estimated initial structural damage in WTC 7 due to debris impact from the collapse of WTC 1.[127]

It describes how several columns in the western core lost lateral support in the north-south direction from debris impact damage and buckled prior to failure of the central core columns. This sequence of events differed from the analysis without debris impact damage imposed. The latter analysis correlated with the actual observed sequence of the roof screen wall falling prior to the west penthouse structure. The "best estimate analysis" which included debris impact damage did not correlate with the observed sequence of events at the roof level.

> This suggests that the damage scenario that was imposed in the best estimate analysis was slightly more severe than actually occurred.[128]

How true, and the impact damage estimate described previously included no core damage at all. The description "slightly more severe…" may be another understatement by NIST, and an overestimate of impact damage undoubtedly favors collapse progression.

> The initial westward progression and the overall speed of the collapse was [sic] not sensitive to the extent of the estimated structural damage to WTC 7 due to the debris from the collapse of WTC 1.[129]

But:

> The horizontal progression of failure was sensitive to the extent of the estimated initial structural damage in WTC 7 due to the collapse of WTC 1.[130]

So which one is correct?

[126] NCSTAR 1-9, pp. 599-600.

[127] NCSTAR 1-9, p. 606.

[128] NCSTAR 1-9, p. 606.

[129] NCSTAR 1-9, p. 625.

[130] NCSTAR 1-9, p. 612.

Free-fall Acceleration

Kinematic analysis of videos taken of the global collapse proves that the north face, the east face and the entire building descended at free-fall acceleration for 2.25 seconds spanning a height of eight stories.[131]

> …the north face descended at gravitational acceleration, as the buckled columns provided negligible support to the upper portion of the north face.[132]
>
> Global collapse occurred as the entire building above the buckled region moved downward as a single unit.[133]
>
> In Stage 2, the north face descended at gravitational acceleration, as exterior column buckling progressed and the columns provided negligible support to the upper portion of the north face.[134]

Gravitational acceleration—or free-fall acceleration—implies zero resistance was provided by the structural elements below the free-falling mass. If free-fall acceleration is defined such that all available potential energy is converted to kinetic energy in unrestrained motion, then what additional energy was available—and necessary—to yield and fracture multiple supporting steel framing members and connections as the collapse progressed? NIST does not account for this energy requirement during this 2.25-second period in their analyses. NIST simply dismisses this anomaly by saying it was consistent with the global collapse analysis. This brief dismissal is neither convincing nor complete documentation for an authoritative and comprehensive report, and it is not acceptable by any reasonable standard of care.

The Steel Debris

NIST writes:

> …that the building and the records kept within it were destroyed, and the remains of all the WTC buildings were disposed of before congressional action and funding was available for this Investigation to begin. As a result, there are some facts that could not be discerned and, thus, there are uncertainties in this accounting.[135]

The building had been completely evacuated several hours before its collapse. No one was trapped in the debris pile, so there was no need to rapidly dismantle and destroy the

[131] Chandler, "WTC 7 in Freefall—No Longer Controversial" is located at http://www.youtube.com/watch?v=rVCDpL4Ax7I. Chandler, "WTC 7: NIST Finally Admits Freefall (Part I)" is located at http://www.youtube.com/watch?v=eDvNS9iMjzA. Chandler, "WTC 7: NIST Finally Admits Freefall (Part II)" is located at http://www.youtube.com/watch?v=iXTlaqXsm4k. Chandler, "WTC 7: NIST Finally Admits Freefall (Part III)" is located at http://www.youtube.com/watch?v=v3mudruFzNw.

[132] NCSTAR 1A, p. 45.

[133] NCSTAR 1A, p. 48.

[134] NCSTAR 1-9, p. 602.

[135] NCSTAR 1A, p. xxxv.

steel debris. Why was the structural steel disposed of before a proper investigation? Who authorized the disposal of the steel before it could be adequately observed and documented? What are the uncertainties in NIST's accounting that resulted from the disposal of the steel framing, and how has NIST compensated for these uncertainties?

The NIST hypothesis was based, in part, on a "critical study of steel framing" from WTC 7.[136] The NIST report, however, does not attempt to explain the "severe high-temperature corrosion attack" on several WTC steel samples as documented in Appendix C of the FEMA report.[137] A detailed study was recommended by FEMA, but the observed "intergranular melting" of the steel was never reconciled by NIST. If NIST has performed the recommended studies, then why have the results not been published? Otherwise, why has NIST ignored the recommendations made in 2002 for critical research of the unexplained material behavior?

Conclusion

After reading and studying NCSTAR 1A, 1-9 and 1-9A, technical professionals and others must ask themselves several questions.

1. Has NIST followed accepted scientific protocol in its analysis procedure considering all available physical and testimonial evidence?
2. Has NIST presented its hypotheses, analyses and conclusions with clarity, transparency and completeness?
3. Has the NIST documentation answered all of your questions regarding WTC 7?
4. Would you endorse the NIST report?

The NIST analyses demonstrated that it may be possible, under certain unlikely circumstances, for ordinary fire effects to cause severe damage and partial collapse of a high-rise steel structure. NIST has, however, focused entirely on the fire-induced collapse hypothesis and has ignored relevant facts and evidence that lead to a contrary conclusion regarding the *most likely* cause of collapse. It is obvious that NIST engineers were primarily concerned with providing an explanation of what "may have happened" rather than an explanation of the *most likely* cause of collapse considering all relevant data and evidence. The NIST analyses fail to provide a convincing explanation of events observed on 9/11 and in the days and weeks following. Specifically NIST has failed to explain evidence of *extreme* temperatures[138] and the presence of highly reactive pyrotechnic materials discovered in the debris.[139] The NIST analyses, therefore,

[136] NCSTAR 1A, p. 25.

[137] Barnett et al., FEMA 403, Appendix C.

[138] Jones et al.

[139] Harrit et al.

have not fulfilled the legal requirement—as stated in the NCST Act of 2002—to determine the *most likely* cause or causes of the collapse.

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